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Agricultural machinery – Biomass Shredder – Methods of Test

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National Foreword

This Philippine Agricultural Engineering Standards PAES 245:2010, Agricultural machinery – Biomass Shredder – Methods of Test was approved for adoption as Philippine National Standard by the Bureau of Product Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development of the Department of Science and Technology (PCARRD-DOST).

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) through the project "Development of Standards for Agricultural Production and Postharvest Machinery" funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development of the Department of Science and Technology (PCARRD - DOST)

This standard has been technically prepared in accordance with BPS Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate mandatory requirements to conform to the standard.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

In the preparation of this standard, the following documents/publications were considered:

PAES 205:2000 Agricultural Machinery – Mechanical Rice Thresher – Methods of Test

PAES 219:2004 Agricultural Machinery – Forage Chopper – Methods of Test

PAES 222:2005 Agricultural Machinery – Chipping Machine – Methods of Test

AMTEC Test Reports on Biomass Shredder

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1 Scope

This standard specifies the methods of test and inspection for biomass shredder and for shredding part only if with chipping section. Specifically, it shall be used to:

1.1 verify the mechanism, dimensions, materials and accessories of the biomass shredder and the list of specifications submitted by the manufacturer;

1.2 determine the performance of the machine;

1.3 evaluate the ease of handling and safety features; and

1.4 report the results of the tests.

2 References

The following normative documents contain provisions, which through reference in this text constitute provisions of this National Standard:

PAES 103:2000 Agricultural Machinery – Methods of Sampling

PAES 244:2010 Agricultural Machinery – Biomass Shredder – Specifications

3 Definitions

For the purpose of this standard, the definitions given in PAES 244 and the following shall apply:

3.1
biomass
organic materials used as renewable source of energy and other agricultural applications

3.2
overall height
distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the biomass shredder

NOTE: All parts of the biomass shredder projecting upwards are contained between these two planes.

3.3
overall length
distance between the vertical planes at the right angles to the median plane of the biomass shredder and touching its front and rear extremities

NOTE: All parts of the biomass shredder, in particular, components projecting at the front and at the rear are contained between these two planes. Where an adjustment of components is possible, its shall be set at minimum length.

3.4
overall width
distance between the vertical planes parallel to the median plane of the machine, each plane touching the outermost point of the biomass shredder on its respective side

NOTE: All parts of the biomass shredder projecting side wards are contained between these two planes.

3.5
running-in period
preliminary operation of the machine to make various adjustments prior to the conduct of the test until the operation is stable

3.6
shredding efficiency
ratio of the weight of the input biomass materials less unshredded biomass materials, to the total weight of the input biomass materials to the shredder, expressed in percent

3.7
input capacity
weight of biomass material fed into the shredder, expressed in kilogram per hour

3.8
unshredded
biomass material that is not totally cut into strips

4 General Conditions for Test and Inspection

4.1 Selection of biomass shredder to be tested

Biomass shredder submitted for test shall be sampled in accordance to PAES 103.

4.2 Role of manufacturer/distributor

The manufacturer/distributor shall submit specifications and other relevant information about the biomass shredder and shall abide with the terms and conditions set forth by an official testing agency.

4.3 Role of the operator

An officially designated operator shall be skilled and shall demonstrate, operate, adjust, and repair as the case may be, related to the operation of the biomass shredder.

4.4 Test site conditions

The biomass shredder shall be tested as installed for normal operation. The site should have ample provisions for material handling temporary storage, workspace and suitable for normal working condition.

4.5 Test instruments

The instrument to be used shall be calibrated and checked by the testing agency prior to the measurements. The suggested list of test instruments and materials needed to carry out the biomass shredder test is shown in Annex A.

4.6 Test materials

In general, the test materials shall be young coconut ("buko"). The size will depend on the capability of the shredder to be tested. However, the test applicant may request for the use of other biomass material if he wants to know the performance of his machine. The amount of test material to be supplied shall be at least 75% of input capacity of biomass shredder.

4.7 Termination of Test

If during testing, the biomass shredder has a major component breakdown or malfunctions, the test engineer from the official testing agency shall terminate the test.

5 Test and Inspection

5.1 Verification of the technical data and information of the manufacturer

5.1.1 This inspection is carried out to verify the mechanism, dimensions, materials and accessories of the biomass shredder in comparison with the list of technical data and information of the manufacturer.

5.1.2 A plane level surface shall be used as reference plane for verification of dimensional specifications of biomass shredder.

5.1.3 The items to be inspected and verified shall be recorded in Annex B.

5.2 Performance test

5.2.1 This is carried out to obtain and validate data on the overall biomass shredder performance.

5.2.2 Data on biomass materials such as type, size and source shall be recorded.

5.2.3 Test materials to be used.

Test materials prepared for the running-in and for each test trial have the same characteristics and conditions.

5.2.4 Running-in and preliminary adjustment

Before the start of the test, the shredder should have undergone running-in period wherein various adjustments of the shredder shall be made according to the recommendation of the manufacturer. (No other adjustment shall be permitted while the test is on-going).

5.2.5 Operation of the shredder machine

The shredder machine shall be operated at the speed(s) and feed rate(s) recommended by the manufacturer. The same recommended feeding rate shall be maintained during the test run. After the test run, the area and the shredder shall be cleaned and then prepared for the next trial. The procedure shall be repeated for the succeeding test trials.

5.2.6 Test trial

There shall be a minimum of three test trials.

5.2.7 Data collection

5.2.7.1 Duration of test

The duration of each test trial shall commence at the start of the shredding operation and ends after feeding of the last biomass materials and it shall be recorded as operating time.

5.2.7.2 Noise level for power-operated shredding machine

The noise emitted by the machine shall be measured using a noise level meter at the location of the operators and baggers. The noise level shall be measured 50 mm away from the ear level of the feeder and bagger.

5.2.7.3 Speed of components

The speed of the rotating components (e.g. shaft of blade assembly, prime mover shaft) shall be taken using tachometer.

NOTE: Measurements shall be taken with and without load for sub-clauses 5.2.7.2 and 5.2.7.3 as specified in Annex C.

5.2.7.4 Energy consumption of shredding machine

A power meter shall be used to measure electric energy consumption. In case an internal combustion engine is used, the fuel tank shall be filled to its capacity. After each test trial the tank shall be refilled using graduated cylinder. The amount of refueling is the fuel consumption for the test.

5.2.7.5 Data recording and observations

Record sheet for all data and information during the test is given in Annex C.

5.2.8 Sampling

5.2.8.1 Sampling for test material

Before the start of each test trials, take at least ten representative samples of biomass material for determination of material conditions (i.e. size, moisture content)

5.2.8.2 Sampling from output chute

5.2.8.2.1 During each test trial, samples shall be taken from the output chute to be analyzed in the laboratory for the percentage of unshredded biomass material which will be used in the computation of shredding efficiency.

5.2.8.2.2 In the collection of sample in this outlet, use a rectangular box-shaped nylon catch with a dimension of 1.5 m x 0.5 m open at one end of the small side. Three samples shall be collected randomly from this outlet with ten-second duration per collection.

5.2.8.3 Handling of samples

Samples to be taken to the laboratory shall be placed in appropriate containers and properly labeled.

6 Laboratory Analysis

Laboratory analysis shall be made to determine work quality of the shredder. The laboratory test data sheet to be used is given in Annex D.

6.1 Moisture content determination

6.1.1 This shall be taken using oven-dry method.

6.1.2 For each test trial, weigh three-100 g of biomass materials, place in the moisture can and record the weight. Ensure that no moisture is lost or gained by the sample between the time it was collected and when it is weighed in a moisture can. Record the initial weight.

6.1.3 Dry the sample in the oven with temperature of 105°C ± 1°C for 72 hours.

6.1.4 After removing samples from the oven, sample container with samples should be placed in a desiccator and allowed to cool to the ambient temperature.

6.1.5 Weigh the moisture can plus the dried sample. Record the final weight. Calculate the moisture content using Formula in Annex E.

6.2 Determination of Percent Unshredded

In each test trial, unshredded and partially shredded biomass materials from the samples taken from the output chute shall be separated and weighed. The time of collection of the

three samples shall be taken and recorded for the computation of the amount of unshredded biomass material. Percent unshredded and shredding efficiency shall be calculated using equation in Annex E.

Other physical observations on the shredded materials shall be recorded in Annex D.

7 Formula

The formulas to be used during calculations and testing are given in Annex E.

8 Test Report

The test reports shall include the following information in the order given:

8.1 Title

8.2 Summary of Results

8.3 Purpose and Scope of Test

8.4 Methods of Test

8.5 Description of the Machine

Table 1 – Machine Specifications

8.6 Results and Discussions

8.7 Observations (include pictures)

Table 2 – Performance test data

8.8 Names, signatures and designation of test engineers

Annex A

Suggested List of Field and Laboratory Test Instruments and Materials

A.1	**Instruments**	**Quantity**
A.1.1	**Field**	
A.1.1.1	Tachometer (contact type or photo electric type) Range: 0 rpm to 5,000 rpm	1
A.1.1.2	Digital timers (range: 60 minutes) Accuracy: 0.1 sec.	2
A.1.1.3	Tape measure (with maximum length of 5m)	1
A.1.1.4	Noise level meter Range: 30 dB(A) to 130 dB(A)	1
A.1.1.5	Weighing scale (capacity: 100 kg) Scale division: 0.5 kg	1
A.1.1.6	Graduated cylinder (for engines) (500 mL capacity)	1
A.1.1.7	Power meter (for electric motors) 60 Hz, 220 V	1
A.1.1.8	Psychrometer	1
A.1.1.9	Digital camera	1
A.1.2	**Laboratory**	
A.1.2.1	Weighing scale (sensitivity: 0.1g)	1
A.1.2.2	Air oven	1
A.1.2.3	Dessicator	1
A.1.2.4	Sample container	9
A.2	**Materials**	
A.2.1	Sample bags	
A.2.2	Labeling tags which include	
A.2.2.1	Date of test	
A.2.2.2	Shredder on test	
A.2.2.3	Sample during shredding	
A.2.2.4	Sample after shredding	
A.2.2.5	Trial number	

Annex B

Specifications of Biomass Shredder

Name of Applicant/ Distributor: _____
Address: _____
Tel No: _____
Name of Manufacturer: _____
Address: _____
Tel No: _____

GENERAL INFORMATION

Make: _____ Type: _____
Serial No: _____ Brand/Model: _____
Production date of Biomass shredder: _____
Testing Agency: _____ Test Engineer: _____
Date of Test: _____ Location of Test: _____

Items to be inspected

ITEMS	Specification of Manufacturer	Verification by the Testing Agency
B.1 Main Structure		
B.1.1 Overall dimensions, mm		
B.1.1.1 length		
B.1.1.2 width		
B.1.1.3 height		
B.1.2 Weight without primemover (kg), if applicable		
B.2 Loading hopper		
B.2.1 Material		
B.2.2 Bottom opening, mm		
B.2.2.1 length		
B.2.2.2 width		
B.2.3 Height from the ground, mm		
B.3 Shredder assembly		
B.3.1 Blade cover		
B.3.1 Type		
B.3.2 Materials		
B.3.3 Blade		
B.3.3.1 Material		
B.3.3.2 Dimensions, mm		
B.3.3.2.1 length		
B.3.3.2.2 width		
B.3.3.2.3 thickness		
B.3.3.4 Shape		
B.3.3.5 No. of blades		

B.3.3.6 Clearance to the shredding cylinder, mm		
B.4 Output chute		
B.4.1 Material		
B.4.2 Dimensions, mm		
B.4.2.1 length		
B.4.2.2 diameter/width		
B.4.3 Height from the ground		
B.4 Safety devices(enumerate)		
B.5 Special features(enumerate)		
B.6 Prime mover		
B.6.1 Electric Motor		
B.6.1.1 Type of motor		
B.6.1.2 Brand		
B.6.1.3 Make or manufacturer		
B.6.1.4 Serial number		
B.6.1.5 Rated power, kW		
B.6.1.6 Rated speed, rpm		
B.6.1.7 Frequency, Hz		
B.6.1.8 Voltage		
B.6.2 Internal Combustion Engine		
B.6.2.1 Brand		
B.6.2.2 Model		
B.6.2.3 Make or manufacturer		
B.6.2.4 Serial number		
B.6.2.5 Type		
B.6.2.6 Rated power, kW		
B.6.2.7 Rated speed, rpm		
B.6.2.8 Cooling system		
B.6.2.9 Starting system		
B.6.2.10 Weight, kg		

Annex C

Performance Test Data Sheet

Test Trial No. _____ Date: _____
Test Engineer: _____ Location: _____
Assistants: _____ Test Specimen: _____
Test Requested by: _____ Manufacturer: _____

	Trials			Ave
	1	2	3	
C.1 Information of Test Materials				
C.1.1 material				
C.1.2 variety				
C.1.3 source				
C.1.4 weight, kg				
C.1.5 moisture content, %				
C.1.6 Dimensions, mm				
C.1.6.1 length				
C.1.6.2 width/diameter				
C.1.6.3 thickness				
C.2 Temperature, °C				
C.2.1.1 Wet-bulb temperature				
C.2.1.2 Dry-bulb temperature				
C.3 Weight of input, kg				
C.4 Weight of output, kg				
C.5 Operating time, sec.				
C.6 Input capacity, kg/h				
C.7 Shredding efficiency, %				
C.8 Speed of components, rpm				
C.8.1 Prime mover				
C.8.1.1 Without load				
C.8.1.2 With load				
C.8.2 Shredder shaft				
C.8.2.1 Without load				
C.8.2.2 With load				
C.9 Noise level, dB(A)				
C.10 Power consumption (for electric motor)				
C.10.1 Power, kW				
C.10.1.1 Without load				
C.10.1.2 With load				
C.10.2 Current, A				
C.10.2.1 Without load				
C.10.2.2 With load				
C.10.3 Voltage, V				
C.10.3.1 Without load				
C.10.3.2 With load				
C.11 Fuel consumption (for internal combustion engine)				

C.11.1 Fuel consumed, mL				
C.11.2 Fuel consumption rate, L/h				
C.13 Welding Acceptance Test				
C.13.1 Crack prohibition				
C.13.2 Weld/base-metal fusion				
C.13.3 Crater cross section				
C.13.4 Weld profile				
C.13.5 Time of inspection				
C.13.6 Undersize welds (if any)				
C.13.7 Undercut				
C.13.8 Porosity (presence of air holes on the welded part)				

C.14 Evaluate the following observations:

Items	Remarks
C.14.1 Ease of loading	
C.14.2 Ease of operation	
C.14.3 Ease of adjusting parts	
C.14.4 Ease of repairing of parts	
C.14.5 Ease of collecting output	
C.14.6 Ease of cleaning parts	
C.14.7 Safety	
C.14.8 Availability of the switches needed	
C.14.9 Ease of transporting the machine	
C.14.10 Vibration	

C.15 Other Observations:

_____

_____

_____

_____

_____

_____

_____

Annex D

Laboratory Test Data Sheet

Machine Tested:_____ Analyzed by:_____
Date of Test: _____ Date Analyzed: _____

D.1 Moisture Content Determination (Oven Method)

Item	Trial 1			Trial 2			Trial 3			Average
	1	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	
Initial weight, g										
Final weight, g										
Moisture content, %										
									General Average	

D.2 Determination of Unshredded Samples

Trial	Weight of unshredded biomass materials, g	Weight of partially shredded biomass materials, g	Duration of collection, s	Total weight of unshredded material, g
1				
2				
3				
Average				

D.3 Other physical observations on cut material

_____
_____
_____
_____
_____

Annex E

Formula

E.1 Moisture Content

$$\text{Moisture content, \% w.b.} = \frac{M_o - M_1}{M_o} \times 100$$

where:

M_o = initial mass of the sample, g
M_1 = final mass of the sample, g

E.2 Input Capacity

$$C_i = \frac{W_i}{T_o}$$

where:

C_s = input capacity, kg/h
W_i = weight of input biomass material, kg
T_o = operating time, h

E.3 Unshredded Biomass Material

a) Amount $= \frac{W_{us} + W_{ps}}{T_c} \times T_i$

b) Percent (U_{bm}) $= \frac{W_{us} + W_{ps}}{W_i} \times 100$

where:

U_{bm} = percent unshredded biomass materials, %
Wus = weight of the unshredded biomass materials, kg
Wps = weight of the partially shredded biomass materials, kg
Tc = duration of sample collecting in output chute, h
Wi = weight of total input biomass material, kg

E.4 Shredding Efficiency

$$Eff_s = 100 - U_{bm}$$

where:

Eff_s = shredding efficiency, %
U_{bm} = percent unshredded biomass materials, %

E.5 Fuel Consumption Rate

$$F_c = \frac{F_l}{T_o}$$

where:

F_c = fuel consumption rate, L/h
F_l = amount of fuel consumed, L
T_o = Time of operation, h

Philippine Agricultural Engineering Standards

AMTEC-UPLB – PCARRD Project: "Development of Standards for Agricultural Production and Postharvest Machinery"

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